The Mines of Khetree in Rajpootana.—*By Col.* J. C. Brooke.

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Khetree is situated at the foot of the Arabullee range of hills, which, running south-west and north-east, divides Rajpootana into two portions, separating the fertile eastern states from the more desert western ones. The Arabullee, commencing south of Oodeypore, and touching the western shores of the fairy lakes of that capital, supports the table-land of Meywar, till, opening into numerous spurs, among which dwell the brave and faithful Mhairs, perhaps the only race in India who have accepted the British rule in full and unreserved confidence, it passes Ajmere. From Ajmere the Arabullee tends a little more to the east, dividing Jeypore proper from Shekhawattee, and at the extreme north eastern corner of the latter district, the Arabullee meets the Tourawattee and Ulwar ranges of hills, the direction of which is generally north and south.

At this extreme corner, some lofty spurs occur, on one of which the hill fortress of Khetree above the town of that name, Pl. I., and on another, that of Bagore are placed. The spurs of these hills run south east and north west, at right angles to the main range, which has a south west and north east direction. In these spurs are rich mines of Iron, Copper, Alum and Cobalt, and perhaps other minerals exist, which a careful examination of the rocks may bring to light. Attention must soon be directed to this region, in the prosecution of the search for coal,* which the extension of railways will necessitate, and to judge from the variety and character of the rocks, there are few places deserving of more careful examination than Khetree.

The little state of Khetree is an allodial Fief belonging to a Rajah, but under the sovereignty of Jeypore, to which it pays a quit rent for some of its pergunnahs, of Rs. 80,000 a year. Khetree enjoys a net revenue of about three lakhs a year, of which, however, very little is the produce of the mines.

The town of Khetree contains about 1000 or 1500 houses, among which are those of a few wealthy families, the most notable of whom has constructed a large and magnificent temple at the entrance of the

* No published notice of the Geology of Rajpootana with which we are acquainted, mentions the occurrence of the coal-bearing rocks in Rajpootana.—Eds.

town. The founder of it amassed his wealth in the situation of Commissariat Gomashtah at Cawnpore, on a small salary. Generally speaking, the people of Khetree are poor, partly owing to the lawless character of the Shekhawattee population, which prevents much trade or commercial enterprize, and partly to the oppressions of the various Kamdars and managers during the long minority of the present Rajah.

Amongst the poorest of the Khetree population are the miners. These are of two races, Hindoos and Mussulmans. The Hindoos work the alum and sulphate of copper works, whilst the Mussulmans confine themselves to the ores which require smelting.

The mines, as before remarked, are situated in the small ranges of hills near Khetree. One of the largest of those now worked, though not the most profitable, is the "*Koolhán*" mine, and a description of the process, carried on at this, will suffice as an example of the whole.

The approach to the *Koolhán* mine, about half a mile from the town, is over hills of clay slate, through which granite, iron stone and other rocks have forced themselves. Along the same spur, which runs from Khetree to Singhana, are several other copper mines, intermixed with sulphate of copper and alum mines, which predominate as Singhana is approached.

The entrance to the *Koolhán* mine is 300 feet above the plain below. The mine descends at an angle of about 60° in a zig-zag, but in a very irregular course, and branches off in various directions. Sometimes, for ten or twenty yards, it is only just sufficient to admit the recumbent body of a man, and at others, opens out into considerable chambers, according to the richness of the rock, from which the ore has been not fairly "*worked*," but one may say, "*stolen*." The richest ore, as frequently happens, is at the greatest depth; but there the mine is generally choked with water. This is the great difficulty the miners experience. Their only means of getting rid of the water, in consequence of the tortuous course of the mine, is to form a chain of human beings from the mouth of the mine to the water, along which ghurrahs are passed by hand, filled with water and the rocky debris, which neglect has allowed to accumulate in the mine. This is a slow and expensive process. In one branch of the *Koolhán mine*, no less than 27 people were required for the purpose, and as each occupied as nearly as could be estimated, 8 feet, it gave 216 feet as the depth of the working. The labour of emptying is continued day and night. On

this occasion, upwards of a month had been expended in this primitive and inefficient process, and the cost was about 200 Rupees. To clear the whole mine properly would require about Rs. 2,000, which is a sum, those employed in the trade could ill-afford to lay out.

The richest mines in Khetree are lying useless from being thus choked. There is one especially, the ore from which the miners confidently affirm contains 75 per cent. of pure metal. It is situated near a running stream, and various traders have expended large sums to clear this mine, but hitherto without result.

At Baghore, a fortified hill about 200 feet higher than Khetree, are other mines of copper intermixed with cobalt, the latter alternating in thin layers with the copper.

The copper mines are owned by the miners themselves, whose ancestors discovered them in former times. The larger are managed by a punchayet, on behalf of the mining community, who are descended from the ancient discoverers. Some of the smaller mines are owned by traders, who have bought them up, either from the original discoverers, or else gradually from their descendants, as these have become involved in difficulties, and have pawned or made over their shares to the traders; who pander, for their own interests, to the unthriftiness for which all such men are noted. The larger mines do not appear to have shared this fate.

Each year, after the rainy season the various branches of each mine are put up to "auction" by the punchayet. The *Koolhán* mine has six or seven branches. The miners themselves are the bidders. Each branch of the Koolhan mine sells for from Rs. 50 to 100 a year, and the whole mine fetches from Rs. 400 to Rs. 600, which is a small sum, considering the rich treasures existing in it.

Each branch of the mine is jealously watched by the miner who purchases it, and who hires other miners as laborers on two annas per diem. Were the mine not guarded, these laborers might purloin the ore and sell it.

The miners work in gangs, and a party of eight men, starting in the morning at about 8 o'clock, will bring back from $2\frac{1}{2}$ to 3 maunds of ore by the evening. The ore is brought in small baskets, weighing about 6lbs. each, and is then put up to auction, in the same manner as is done with the ore obtained from the mines still in the hands of the original proprietors, or the traders. The auction takes place at

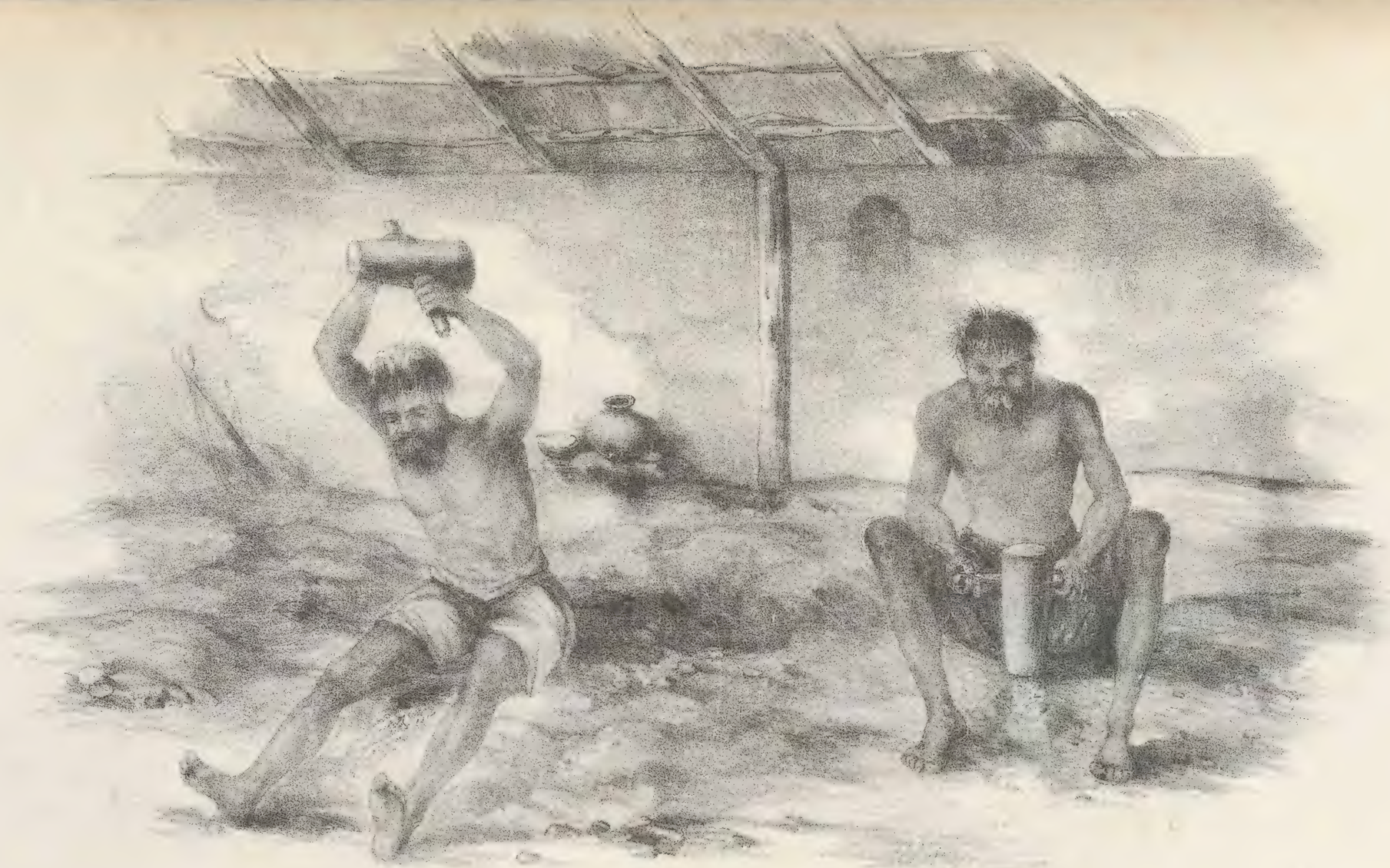
the town of Khetree itself, and furnishes a scene of much excitement. The purchasers are Mussulman Bhoras, who conduct all the subsequent operations; and here the interest of the miners entirely ceases in the produce of the mines. If the ore is black sulphuret of the first class, it will fetch as much as Rs. 10 per maund of $26\frac{1}{2}$ seers; but if good pyrites, perhaps Rs. 4 or 5 a maund. The pyrites is much the most plentiful ore, but there are several poorer ores fetching as low as Rupee 1 a maund.

The Borah having concluded his purchase, employs a man with a small hammer, who receives Rs. 3 per month, to separate the ore from the schistose rock and quartz, (with which it is intermingled in about equal quantities), and to break it into small pieces.

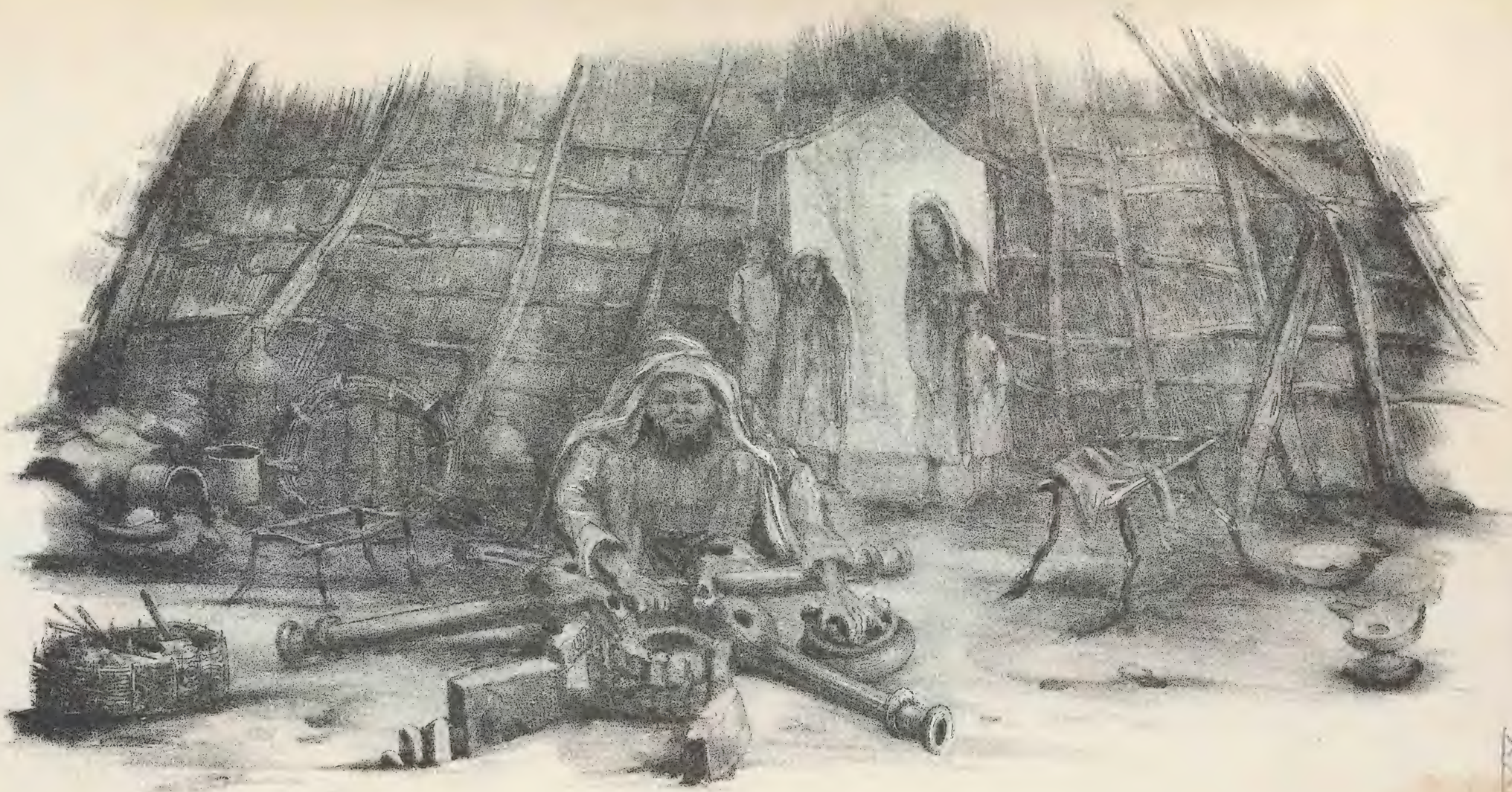
The ore has now to be finely powdered. This is done by men using 'Ghuns' or heavy hammers, weighing from 32 to 34 pounds each. The hammer is lifted with both hands, one on either side of the hammer head and brought down with great force on a small heap of the ore, raked into place with the toes, that never failing substitute for the hand among natives: as this is the most laborious operation in the whole process, only the strongest men are employed. Pl. II. The ore has to undergo the hammering three times before it is fine enough for the roasting process. A Ghun man on coming to his work very early in the cool of the morning has five maunds of ore weighed out to him, this is his proper quantity for a day's work, and is as much as can be supplied daily by the coarse breaker. Preparing this properly, gives the Ghun laborer six hours of hard unremitting work, and his wages are proportionately high, viz., five rupees a month.

The ore, having been reduced to a proper state, is next mixed with cow-dung, and made into rolls about four inches long, which are first dried in the sun, and then roasted in the open air, in a fire of cow-dung cakes. This is an inexpensive process, costing only a few annas for cakes to roast five maunds of ore.

The ore is now ready for the smelting furnace. For this, Koomhars or potters are employed. The potter builds and works his own furnace, and supplies the bellows; in fact extracts the metal. Four people, one of whom may be a child 12 or 14 years old, are required for each furnace. They receive collectively Rs. 11 a month. The furnace is about $3\frac{1}{2}$ feet high and 12 inches in diameter, built of pieces of slag



No. 2. Pounders of Ore with "ghuns" weighing 32 to 34 lbs each.



No. 3. Koomhar making a smelting Furnace for Copper Ore

cemented with clay in a most primitive manner Pl. III.; and the nozzles of the bellows are built up in it. The nozzles are earthen tubes which are thickest at the furnace end, and at the top of the thick part is a small air hole, usually closed with a piece of wet rag, but opened now and then to clear the tubes. The other end of the tube is fixed to the bellows bag. The bellows valve is formed by two sticks at the mouth, which are opened when the bag is raised for the admission of air, and closed when the bellows are pressed down with force by the bellows men, who use both hands for the purpose. The upper part of the furnace is formed with rings of fire clay, about 10 inches deep. The bellows are worked on three sides, while on the fourth is the opening to the furnace, in which a plate of fire clay is placed, at the lower part of which is a hole for stirring the molten metal and allowing it to flow out. Pl. IV.

The furnace is prepared daily, each smelting occupying about 12 to 14 hours. After the furnace has been lit and well heated, the roasted ore is gradually introduced, alternately with charcoal and the flux which is called "Reet." This is the refuse from old iron furnaces, of which hills of debris still remain, the iron having been worked for ages before the copper ore was discovered. At each operation, five maunds of roasted ore is gradually introduced into the furnace; this requires an equal amount of the "Reet," and four maunds of charcoal to smelt it.

The produce of course varies with the description of ore. The poorest kind, which is sold for eight annas a Khetree maund, and the value of which is doubled by the cleaning and crushing, will produce, at the lowest rate, twenty seers of unrefined copper, which in refining is again reduced one-half, leaving only ten seers. This would make about 303 Tukkas in copper pice.

The expenses may be calculated as follows:—

5 maunds ore, ... Rs.	5	0	0
Hammer-men, ...	0	5	0
4 maunds charcoal at 31 maunds per 12 Rs. ...	1	4	0
5 maunds flux at 20 maunds per rupee, ...	0	4	0
Koomhars for smelting $\frac{11}{30}$, ...	0	6	0
Refining, ...	0	8	0
Total, ...	7	11	0

Raj share $\frac{1}{4}$ of 9 rupees,

The produce will be ten seers as before stated or 303 Tukkas, and deducting $\frac{1}{4}$th, the share of the Raj, &c., 228 Tukkas worth about Rs. 9 will be left. If we take from this the expenses Rs. 7-11, the net profit will be Rs. 1-5 per diem, but allowing for extras, roasting not charged, etc. we may reckon it at 1 Rupee per diem, when the ore is poor.

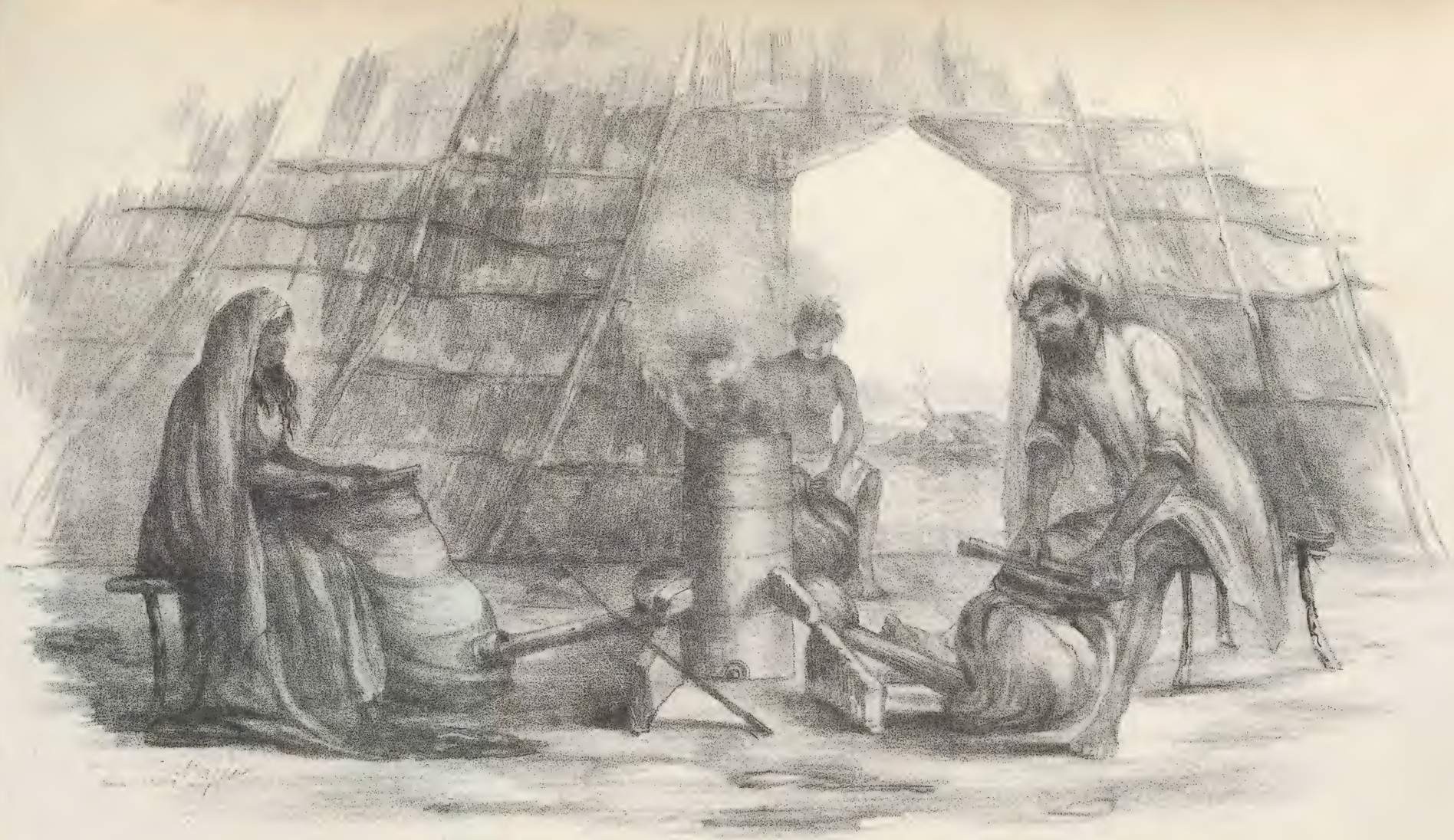
There is sometimes a loss in the smelting operations, but the Bohrahs take their chance of this, the gain sometimes being very considerable. On an average it may be reckoned at about 2 rupees on each smelting.

After the ore has been smelted, the metal has to be refined, and the sulphur driven off. This is done by passing a very strong current of heated air over the liquid mass, and constantly skimming it. Pl. V. To obtain the blast a single bellows is used, which is worked by one man opening and drawing it up, and two others pressing it forcibly down with their feet, placing their whole weight on the bellows, and maintaining their balance by means of ropes fastened to the roof of the building.

About one maund is refined at a time, which produces about 20 to 25 seers of good copper. The refining is contracted for at 8 annas the maund. The process requires about three hours, and the men are paid $1\frac{1}{2}$ annas per diem each. When the pot in which the refining has been conducted is ready, the ore is poured into small earthen troughs prepared on the ground for the purpose, and is then taken to the mint for weighment and duty.

The measure at the Khetree mint is the Shahjehanee maund, equal to $36\frac{1}{2}$ seers of the Jeypore maund, but only to 30 seers of the Khetree maund. In the Shahjehanee maund are 1,212 Tukkas or 2,424 pice. Of this, the Khetree Rajah takes 269 Tukkas as his share. Twenty-two Tukkas go to the coiners for their trouble in converting the copper into pice; nine to the Darogah of the mint; two to the weighmen, and four to caste charities; total 306, leaving 906 to the smelter. Twenty-six Tukkas at Khetree sell for the rupee, whereas at Jeypore usually only twenty Tukkas can be procured for the same. The value of 906 Tukkas at Khetree would be Rs. 34-12 nearly.

In some of the mines, a sulphuret of cobalt is found in thin layers, between the masses of copper ore. No great quantity of this is pro-



No. 4. Copper Ore smelting furnace in play.